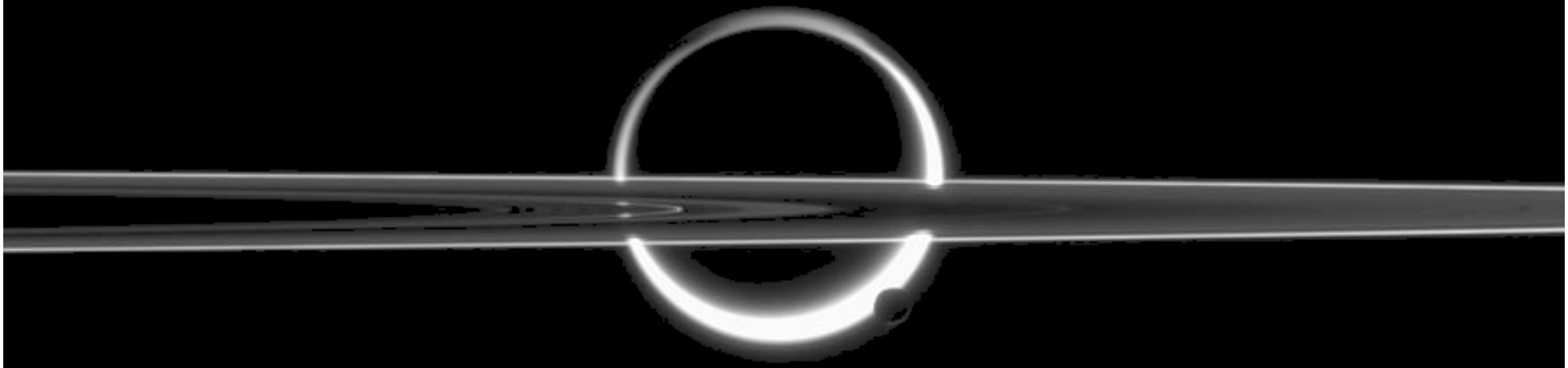
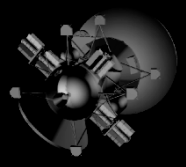
Titan Saturn System Mission Orbiter Science Scenarios





Presentation at OPFM Instrument Workshop

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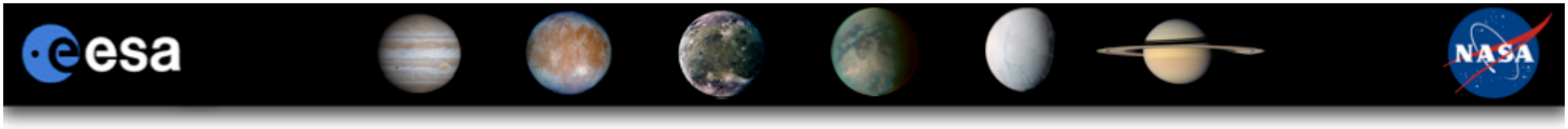
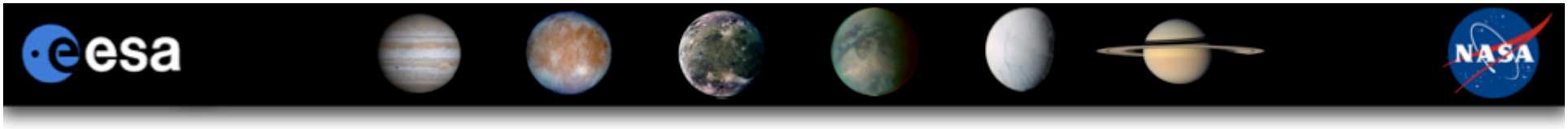


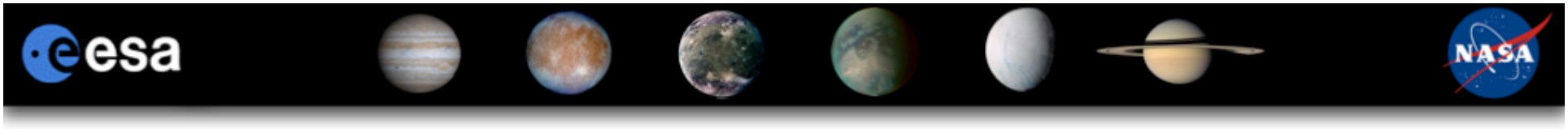
Science Scenario Phases

- Cruise Phase – 1 Venus, and 2 Earth flybys
    - Opportunities to exercise operations processes and calibrate instruments
- Tour Phase –
    - Saturn Orbit Insertion
    - Observe Enceladus and Titan during Flybys
        - 4 Enceladus
        - 15 Titan
    - Relay data rates vary with range to Titan (11 million to a few thousand kilometers)
    - Aerosampling – Collect atmospheric data during aeropasses, remote sensing when outside atmosphere
- Orbital Phase (Discussed on the following slides)



Titan Orbit Scenario Analysis

- Modeled spacecraft and instrument performance to find compatible combinations given constraints.
- Designed a 2-year feasible plan that accomplishes science goals using the current spacecraft resources, with margin.
- Other options are available
  - Considered and modeled other campaigns that can serve as science planning tools.



Scenario Modeling

- Scenario Analysis Tool estimates data volumes and power balance for different orbit scenarios
  - Simulation runs in 1 minute steps for one entire orbit
  - All instruments represented as Data Rate, Power states
    - on, standby, off
    - Data rates, data reduction factors
    - On duration represented as a duty cycle defined as percent of orbit period
  - Output
    - Data accumulation in SSR, total data from each instrument
    - Power state, battery state: required to balance energy each orbit
- Campaigns are combinations of instruments to assess feasibility
  - Scenario Analysis Tool can estimate many combinations quickly
  - Scenarios are groups of campaigns that meet science goal sets

Sample TSSM Science Campaigns – Orbit Phase

- 3 types of science campaigns, each designed to manage power and data rate.

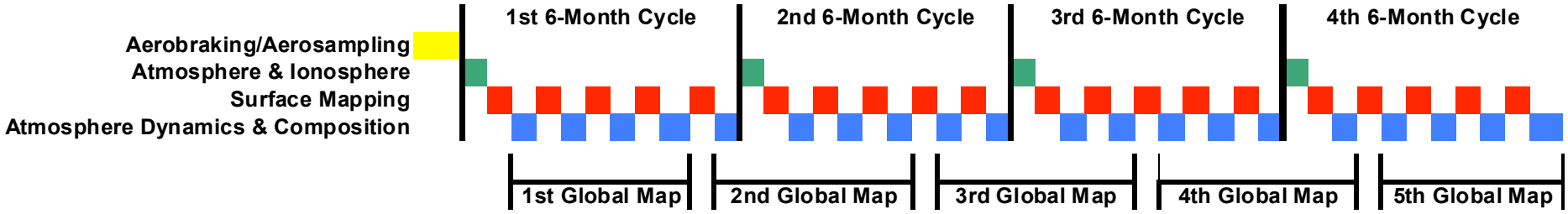
  - Atmosphere & ionosphere: identify and measure ions and neutrals globally for various Sun angles. (PMS and MAPP)

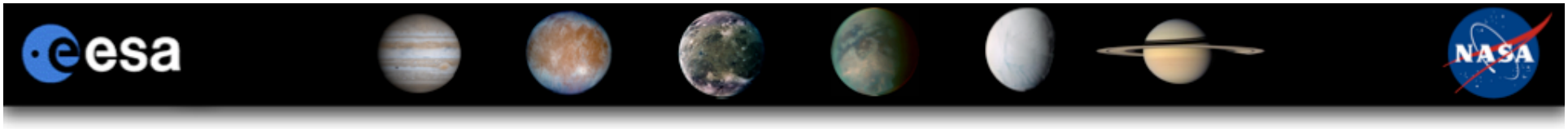
  - Surface map: global map in up to 4 colors; global altimetry with better than 10-m accuracy; surface spectroscopy. (HiRIS, TiPRA, MAPP)

  - Atmospheric dynamics and composition: measure temperatures, composition, and winds, globally. (TIRS and SMS)

Maintain each orbit type (campaign) for 16 days (1 Titan revolution)

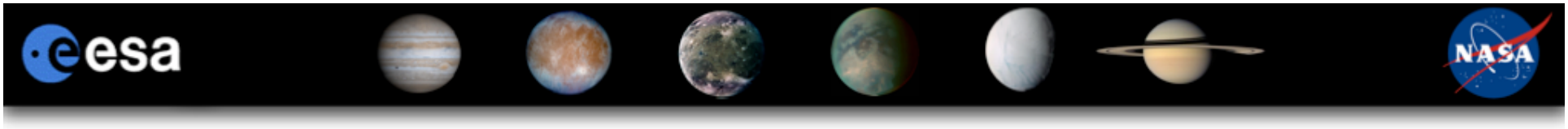
6-month cycle= eleven periods of 16 days.





Constraints in Scenario Modeling

- Power - Total of 110W shared between Telecom and the instruments
  - HiRIS 32W
  - TiPRA 15W
  - MAPP 16W
  - Telecom 83W
  - SMS 40W
  - PMS 25W
  - TIRS 15W
- 25 Amp-hour battery must be recharged in each orbit
- Telecom - Worst-case data playback rate assumed (50kbps)
- SSR – 32Gb capacity will be balanced among campaigns

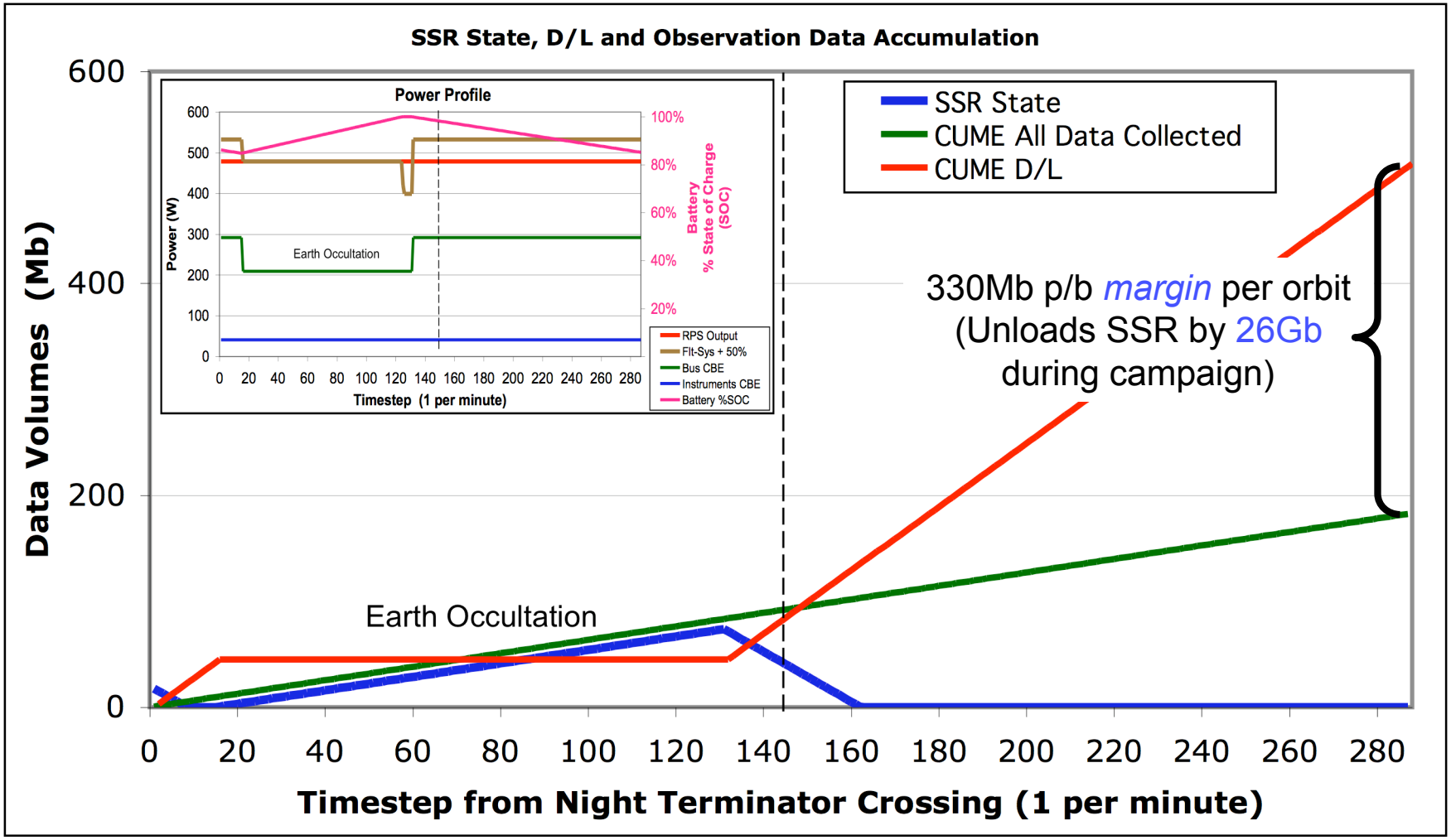


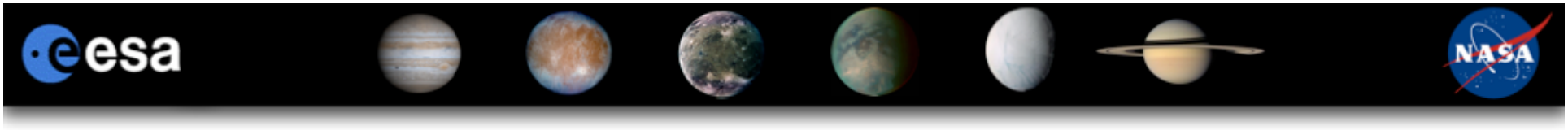
Sample Orbital Mission Scenario

- Maintain each campaign for 16 days (one Titan revolution)
- 6-month cycle= eleven campaigns of 16 days, each

16-day campaigns (80 orbits)	**Type of orbit**	**Comments**
1	Atmosphere/Ionosphere PMS and MAPP	Unloads SSR **26 Gb**
2, 4, 6, 8, 10	Surface map (even-numbered 16-day campaigns) HiRIS, TiPRA, MAPP	Loads SSR **20.6 Gb** Takes four 16-day campaigns for one color map
3, 5, 7, 9, 11	Atmosphere dynamics & Composition (odd-numbered 16-day campaigns) TIRS, SMS	Unloads SSR **25.8 Gb**
Repeat	Three types of orbits in the pattern, above.	

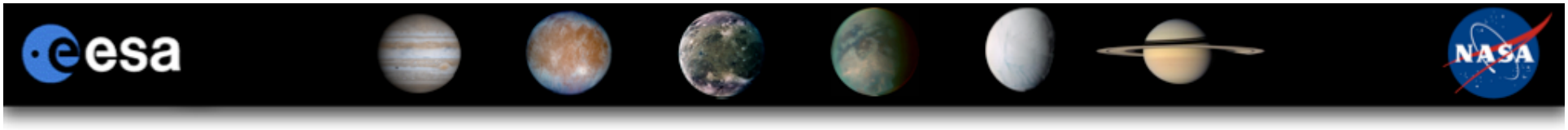
Atmosphere & Ionosphere: PMS and MAPP 100% Duty Cycle





Sample Orbital Mission Scenario – Summary

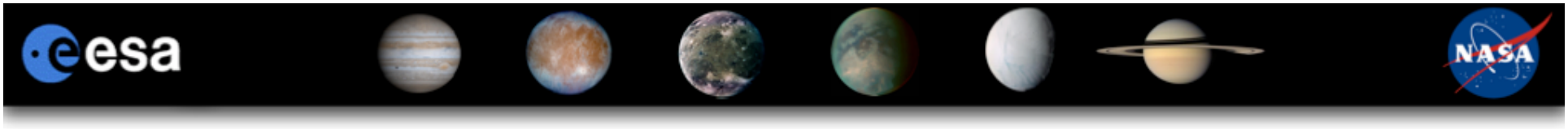
Campaign	**Duty Cycle**	**Comments**
Atmosphere/Ionosphere: (PMS and MAPP)	PMS 100% MAPP 100%	330Mb p/b margin per orbit. Unloads SSR by 26Gb during campaign
Surface map: HiRIS, TiPRA, MAPP	HiRIS 40% TiPRA 100% MAPP 100%	260Mb net data accumulation per orbit. Loads SSR by 20.6Gb during campaign
Atmosphere dynamics & Composition: TIRS, SMS	TIRS 100% SMS 100%	320Mb p/b margin per orbit. Unloads SSR by 25.8Gb during campaign



Other Scenarios were Considered

Campaign	Duty Cycle	Comments
TiPRA, PMS, MAPP	TiPRA 100% PMS 100% MAPP 100%	109Mb p/b margin per orbit. Unloads SSR by 8.8Gb during campaign
PMS, SMS, TIRS, MAPP	PMS 50% TiPRA 75% SMS 50% MAPP 100%	230Mb p/b margin per orbit. Unloads SSR by 18Gb during campaign
HiRIS, TIRS, MAPP	HiRIS 40% TIRS 40% MAPP 100%	250Mb net load per orbit. Loads SSR by 20Gb during campaign

* Not necessarily meant to execute in the order listed.



Scenario Summary

- The first scenario, with 6-month cycles, is an example of a workable 2-year plan, given the current power and data-flow constraints.

- As science requirements are assessed and new needs arise, a variety of other campaigns (instrument combinations) can be modeled for consideration